National Aeronautics and Space Administration

Multisensor Fire Observations

www.nasa.gov

NASA satellite observations of the Earth are providing scientists and fire managers with unparalleled insight into how deadly fires behave and how to fight them. NASA is providing the "big picture" needed to understand fires before they start, while they burn, and after their damage has been done.

Video Animation Sequence

Fire Season 2002

The 2002 U.S. fire season was one of the worst in half a century. The Multisensor Fire Observations animation features NASA's Earth system science data from multiple Earth-observing satellites acquired from October 2001 to September 2002. The use of interdisciplinary data contributes to a better understanding of the relationships between environmental factors and fires.

As the globe rotates to the east, the fires detected by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instrument flare and fade. In this animation, bright red dots (pixels) mark 1-square-kilometer areas where active fires have been detected. Since each pixel may not be filled with fire, the area burning may be overestimated. Dots change color from red to yellow after a few days and to black when fires burn out.

From brush fires in Africa to forest fires in North America, many of NASA's Earth-observing satellites have the capability to locate every significant fire on Earth to within 1 kilometer.

The point-of-view changes to center on the continental United States, where in 2002 some 71,200 fires burned over 7.1 million acres. During the summer and fall fire-burning seasons, particularly destructive fires occurred in Colorado, Arizona, and Oregon.

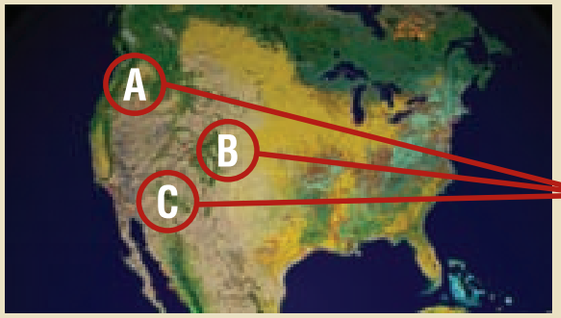
The unique view from space allows wildfire and disaster management teams to monitor fires and understand their impacts. Using MODIS fire products, these teams are able to measure both the intensity and spread of fires and to allocate scarce resources more efficiently, thus minimizing loss of life and property and preserving the forests.

Many factors contribute to the occurrence of severe fires, including changing weather patterns, drought, changing land use and land management, and in some areas the accumulation of dry vegetation resulting from fire suppression efforts.

The animation shows the relationships of fires to wind and rainfall patterns, aerosols, land cover, and human habitation. Starting with clouds and rainfall, the animation depicts rainfall rates in red and orange. Lack of rainfall in the western United States heightens the risk for fire.

NASA satellite observations of greenhouse gases and aerosols can track the movements of fire-generated gases and smoke. This ability allows better predictions of hazardous air quality conditions for various population centers.

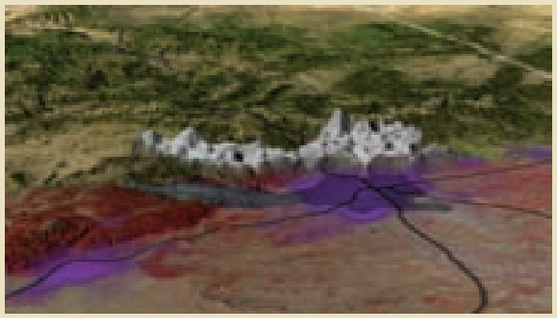
Combining clouds with aerosol data, the animation tracks smoke particles as they are carried by winds to distant locations.



Satellite sensors reveal different types of land cover, from deserts (tan) to croplands (yellow) to forests (green). These data can be useful in assessing fire damage.

The animation zooms in to closely study three large fires:

- Hayman (B)
- Rodeo-Chediski (C)
- Biscuit (A)

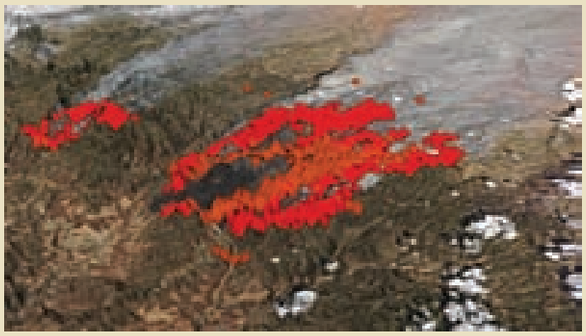


In June 2002, Colorado experienced the Hayman Fire, which burned for nearly a month. From the unique vantage point of space, MODIS fire data from June 8 to 17 track the fire's evolution in location, area, movement, and size of smoke plumes. Fire managers use the data to help them decide where to deploy resources.

The *Gridded Population of the World* overlay shows populated areas, represented by purple shading in this sequence.

Multi-angle Imaging SpectroRadiometer (MISR) multi-angle observations are combined to yield a three-dimensional view of the Hayman smoke-and-soot plume spreading over Denver. The plume reached elevations of a few kilometers above the surface.

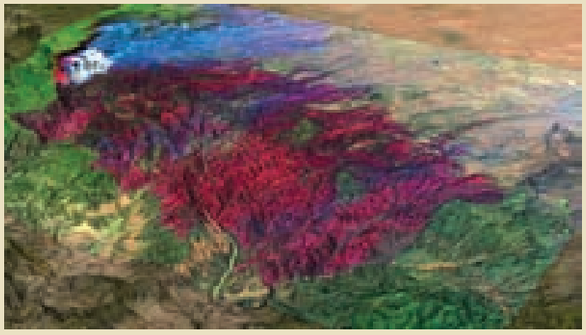
The MODIS land cover data show populated areas in dark red.



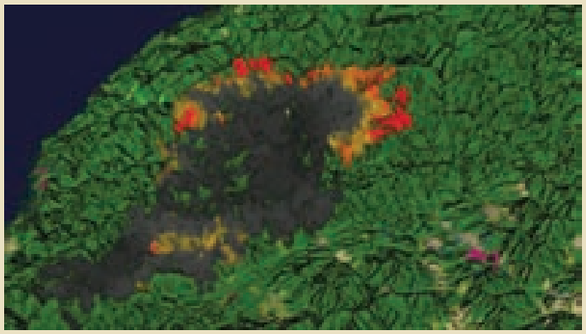
While the Hayman Fire burned, the Rodeo and Chediski Fires in Arizona merged into the largest fire in state history. The MODIS fire product time series shows the evolution of the Rodeo-Chediski Fires from June 18 to 29.

The fires burned about 500,000 acres and resulted in more than $30 million in damages.

Similar multisensor views from space locating hotspots and determining wind directions are now being used to identify those areas at greatest risk.



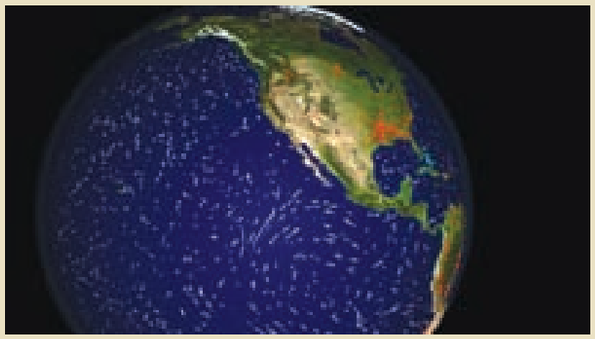
The point-of-view zooms in using Landsat 7 ETM+ data to show details of the burned area from June 21 to July 7. Note that not all of the pine forest within the fires' perimeter has burned to the same degree. High-resolution land data display burned areas in red.



Almost 1 week later, the Sour Biscuit and Florence Fires began in southern Oregon. As updrafts drew the two fires together, they merged and continued to burn as the Biscuit Fire. The MODIS fire product time series shows the development of the Biscuit Fire from July 13 to August 27. The fire ravaged 500,000 acres of forest over 2 months.

The view zooms in using Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) high-resolution (90 meter) thermal data for August 14 to show details of the burned area. Dark purple represents burned areas, and bright purple indicates active fires.

This close-up scene follows the fire's spread and resulting destruction.



The animation concludes with a view of the Pacific Ocean. SeaWinds on QuikSCAT near-surface winds data indicate weather patterns.

NASA's satellites enable us to examine North American fires within in a global weather context. Measuring ocean winds from space adds one more piece to the puzzle of understanding our Earth as a system.

Animation Data Sets

Global Animations

The background comprises three data sets.

1. *Blue Marble* (the most detailed true-color image of the Earth to date. Much of the data in this composite came from the MODIS instrument onboard Terra).
2. Topography based on the *GTOPO30* data set from the U.S. Geological Survey (USGS).
3. Fires from the *MODIS/Terra Thermal Anomalies/Fire 1km** product, with a daily frequency rate. The daily fire products from the MODIS Land Rapid Response Team (University of Maryland at College Park).

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* A MODIS Land Rapid Response System product based on the same algorithm that produces the MODIS MOD14 Fire and Thermal Anomalies product.

Continental U.S. Animations

The U.S. background comprises the global animation data sets and the following three data sets.

1. *Gridded Population of the World* (http://sedac.ciesin.columbia.edu/plue/gpw/).
2. *Major Roads* (1999) by Geographic Data Technologies, Inc., and ESRI (ESRI Data and Maps Media Kit, CD-ROM #2).
3. Political boundaries from the 1993 *CIA World Map* database by Thomas Oetli of the Swiss Meteorological Institute.

The sequence of MODIS-detected fires repeats with four different data sets. Data show the relationships of fires to wind and rainfall patterns, aerosols, land cover, and human habitation.

1. Cloud circulation patterns from May 1 to June 26, 2002, with a 3-hour data frequency. Data are from the *GOES Infrared Global Geostationary Composite* data set.
2. Rainfall patterns range from May 1 to 14, 2002. Data are from the *Daily 1 x 1 Degree TRMM and Other-GPI Calibration Rainfall* data set.
3. Smoke plumes ranging from June 18 to 30, 2002, are overlaid on the clouds animation. Data are from the *TOMS Aerosol Index* daily product.
4. Color-coded Land cover patterns are created from the *MODIS/Terra Land Cover Type 96-Day L3 Global 1km ISIN Grid* data set.

Hayman, Rodeo-Chediski, and Biscuit Fires

The background topography is based on two USGS data sets:

1. *Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) (C-band) 30 Meter.*
2. *High-Resolution National Elevation Dataset (NED) 10 Meter.*

Hayman Fire South of Denver, Colorado

- The MISR data visualizations of land and smoke plume use the *MISR Level 1B2 Ellipsoid Data V001* and *MISR Level 2 TOA/Cloud Stereo Parameters V001* data sets.
- MISR smoke plume and MODIS fire data are sequentially animated over the *MODIS/Terra Land Cover Type 96-Day L3 Global 1km ISIN Grid* data set.

Rodeo-Chediski Fires Northeast of Phoenix, Arizona

- The zoom-in time sequence for the Rodeo-Chediski Fires uses *MODIS/Terra Thermal Anomalies/Fire 1km* geolocated pixels as red dots placed on *MODIS/Terra Calibrated Radiances 5-Min L1B Swath 1km* true-color images to detail land, smoke, and clouds.
- The Landsat 7 ETM+ data visualization of smoke and burned areas uses the *Level-0R WRS-Scene V002* data set.

Biscuit Fire West of Medford, Oregon

- The ASTER data visualization for the Biscuit Fire uses the *ASTER L1B Registered Radiance at the Sensor V003* data set.
- MODIS fire data are animated over *MODIS/Terra Land Cover Type 96-Day L3 Global 1km ISIN Grid* data set.

Pacific Ocean Animation

SeaWinds on QuikSCAT Level 3 Daily Gridded Ocean Wind Vectors data are animated to indicate near-surface wind patterns for September 1 to 30, 2002.

Coincident data sets from various instruments on NASA satellites allow valuable synergistic analyses of fire and its effects on complex, interrelated Earth systems. From the unique vantage point of space, scientists are able to address the questions: "How does fire change the land surface and the atmosphere of the Earth?" and "What are the consequences for life on Earth?"

NASA Earth System Science Data

NASA's Earth Observing System Data and Information System (EOSDIS) manages and distributes Earth science data through Distributed Active Archive Centers (DAACs). Each data center specializes in different Earth system science disciplines.

The data centers provide access to data information, products, tools, and services. For information about the data products used in this animation, contact the data center holding that data.

GES DAAC
http://disc.gsfc.nasa.gov/
- MODIS
  - Calibrated Radiances △
- TOMS
- TRMM

GHRC
http://ghrc.msfc.nasa.gov/
- GOES

LaRC DAAC
http://eosweb.larc.nasa.gov/
- MISR

LP DAAC
http://lpdaac.usgs.gov/
- ASTER
- Landsat 7 ETM+ □
- MODIS
  - Thermal Anomalies/Fires
  - Land Cover

PO.DAAC
http://podaac.jpl.nasa.gov/
- SeaWinds on QuikSCAT

SEDAC
http://sedac.ciesin.columbia.edu/
- Gridded Popluation of the World

Other Earth system science data centers are the ASF DAAC, NSIDC DAAC, and ORNL DAAC.

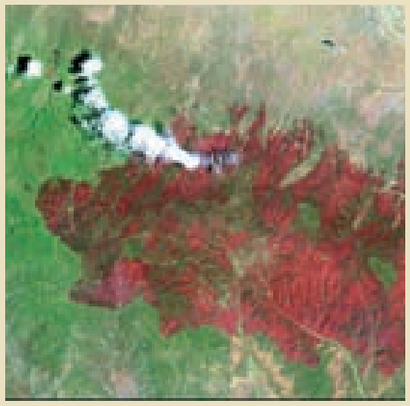
For more information about the data centers, data, and services, see http://nasadaacs.eos.nasa.gov/.

For EOSDIS outreach resources, see http://eos.nasa.gov/outreach/.

△ These products are in transition to MODAPS at http://modaps.nascom.nasa.gov
□ Landsat 7 data has transitioned to the USGS at http://www.usgs.gov

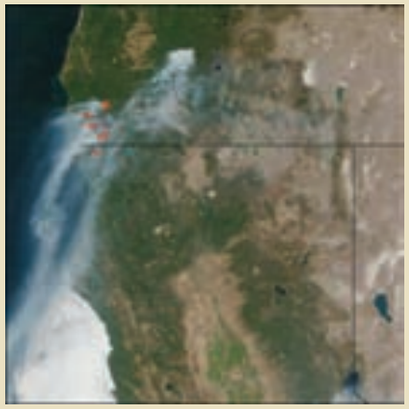
MODIS image depicting the Hayman Fire, burned area, and smoke, June 9, 2002. *(MODIS Land Rapid Response Team, NASA/GSFC)*

MISR image [obtained by the DF camera (70.5° forward from nadir)] showing the Hayman Fire and smoke over Denver, June 9, 2002. *(NASA/GSFC/ LaRC/JPL, MISR Team)*



Landsat 7 ETM+ image revealing burned areas for the Rodeo-Chediski Fires, July 7, 2002. *(USGS EROS Data Center Satellite Systems Branch)*

MODIS image displaying hotspot fires and smoke for the Rodeo-Chediski Fires, June 24, 2002. *(MODIS Land Rapid Response Team, NASA/GSFC)*



MODIS image showing the Biscuit Fire, southwestern Oregon, August 11, 2002. *(MODIS Land Rapid Response Team, NASA/GSFC)*

ASTER thermal image detailing hotspot fires and burned areas for the Biscuit Fire, August 14, 2002. *(Wildfire Response Team, LP DAAC)*

Note: MODIS Land Rapid Response imagery augments MODIS standard land products available from the LP DAAC.

To search and order data through the NASA EOS Data Gateway (EDG), see http://eos.nasa.gov/imswelcome.

To search the comprehensive NASA Global Change Master Directory (GCMD) for data and services, see http://gcmd.nasa.gov/.

For additional fire imagery, see the NASA Earth Observatory at http://earthobservatory.nasa.gov/NaturalHazards.

For additional MODIS fire imagery, see the NASA MODIS Rapid Response System Web site at http://rapidfire.sci.gsfc.nasa.gov/.

For links to NASA Earth science and Space science image galleries, video and interactive features, see http://science.hq.nasa.gov/multimedia/index.html.

Visualization credits:
NASA GSFC Scientific Visualization Studio
NASA ESDIS Science Operations Office
NASA MODIS Rapid Response Team

The content on this *closed-captioned* DVD is presented in widescreen format. For optimum viewing, set the display screen to a 16:9 aspect ratio.

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